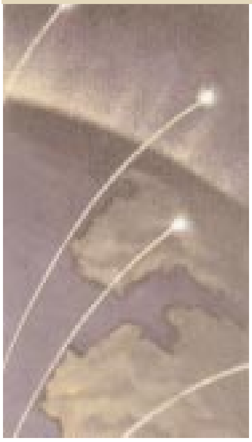

Power Sources

Batteries

Adapting Battery Technology for High-Current Pulse Applications

by Sol Jacobs, Tadiran Batteries, Ltd.

Rapidly advancing technology is causing dramatic growth among variety of high-current pulse applications. High pulse applications involve low-background currents, and brief periods of high-current pulses over an extended period of time. These applications include automotive emergency roadside assistance systems, traffic telematics, GPS tracking devices, oceanographic devices, RFID transponders, automotive meter reading, security devices, emergency equipment, defibrillators and other medical devices.

Lithium batteries are typically preferred for the high-current pulse applications due to their inherent long-life and high-energy density. But with electronic and electro-mechanical devices becoming increasingly complex and feature rich, the performance capabilities of current lithium battery technology is being stretched to the limits. Besides high-energy density and the ability to handle high-current pulses, these applications require a primary battery that can withstand extreme temperatures and harsh environments. Long-life and reliability are also important considerations, as a battery failure leads to system failure for stand alone and remote applications with no back-up power source. For mobile applications, reduced size and weight are important requirements. Safety is always a major concern, as is cost.

One typical example of a high-current pulse application involves tracking the migration patterns of whales using GPS technology. This equipment requires lithium batteries that can generate high-current pulses at periodic intervals, with little or low background current in between signal transmissions. Long-life is essential as whales have long life expectancies, and a battery failure might ruin the experiment. The system must also be small and lightweight, as animals' comfort and safety are critical issues.

Increasingly sophisticated equipment requires increasingly powerful batteries.

Currently, this type of GPS tracking application might rely on three main types of lithium batteries, including:

- Spirally Wound (Jelly Toll)
- Lithium Thionyl Chloride Li/SOCl2 (bobbin)
- Lithium Thionyl Chloride Li/SOCl2 (bobbin, with Hybrid Layer Capacitor)

Each of these technologies offers specific advantages and disadvantages.

Spirally Wound Cells

Lithium batteries that utilize jelly roll construction with spirally wound electrodes including Lithium Sulfur Dioxide or Lithium Manganese Dioxide, deliver high-power and low passivation, with lower energy density and reduced operating life. Spirally wound batteries lack the safety features found in bobbin-type cells. As a result, internal or external shorts can cause the cell to vent or erupt. Self-discharge of these cells is also higher than that of bobbin-type construction.

Figure 1. Tadiran high-energy lithium thionyl chloride batteries are available in a wide variety of sizes and configurations including custom battery packs.

Figure 2. PulsesPlus™ batteries are designed to deliver the higher energy density and storage capacity required by today's high-current pulse applications. They feature exceptional overall performance including a wide operating temperature range, long-life and improved safety.

Lithium Thionyl Chloride (Li/SOCl2 Bobbin

Bobbin-type Li/SOCl2 cells deliver extremely high energy density, high cell voltage, good low temperature characteristics, low self-discharge rate and good safety characteristics.

However, bobbin-type cells have two drawbacks: passivation after storage at elevated temperature, and low current due to its low rate design. As a result, these cells do not have the power capability required for high-current pulses applications. To address these problems, Tadiran Batteries Ltd. created a hybrid system, a high-power/high-energy density cell that combines a bobbin-type Li/SOCL2 cell with a hybrid layer capacitor (HLC).

Lithium thionyl Chloride, Bobbin, with Hybrid Layer Capacitor

Combining bobbin-type Li/SOCl2 chemistry with a hybrid layer capacitor (HLC) resulted in a battery capable of delivering high-energy density and high-current pulses without any passivation or voltage delay problems. Although this was not the first time that Lithium batteries and capacitors were combined, the need for high current pulses did require some special modifications to the capacitor. This technology is currently being utilized in Pulses Plus™ batteries from Tadiran (see Fig. 2).

Two recent applications demon strating the "real world" benefits of batteries that combine $Li/SOCl_2$ with a hybrid layer capacitor. As described below.

Oceanographic Devices

One recent example involves GPS equipment designed to detect underwater movements of the earth's crust as a means of studying plate tectonics, as well as to provide early warning of seismic activity. These systems currently use 120 DD-size Jelly Roll cells for an operating life of about four years. Each pack weighs 25.6 kg., and each DD cell measures 33 mm (diameter) x 125 mm (height).

Converting to Pulses Plus batteries permitted a substantial reduction in the number of batteries required, to just 45 DD-size Thionyl Chloride Bobbin cells plus 45 Hybrid Layer Capacitors, providing four years of service life. The Pulses plus™ battery pack weighs 12.1 kg. Each DD cell measures 33 mm (diameter) x 125 mm (height), and the size of the HLC is 18 mm (diameter) x 65 mm (height).

Converting to Pulses Plus battery packs resulted in 50 percent volume and weight reduction and a cost savings of approximately 75 percent.

Trailer Tracking Device

Another recent application involved a trailer tracking device that spends 30 days a year untethered (not connected to power supply or truck). The battery must provide 10 years of service life.

The present battery power solution requires two large DD Jelly Roll cells, measuring 33 mm (diameter) x 125 mm (height), at a cost of more than $100.

Identical performance was achieved with 2 D-size Pulses

Figure 3.

Li/System	Li/SOCl2 w/Hybrid Layer Capacitor	Li/SOCl2 Bobbin	Spirally Wound
Energy Density (Wh/l)	1420	1420	800
Power	high	low	high
Voltage	3.6 - 3.9V	3.6 V	3 - 3.6 V
Pulse Amplitude	high	small	moderate
Passivation	low	high	moderate
Performance at Elevated Temp.	excellent	fair	moderate
Performance at Low Temp.	excellent	fair	excellent
Operating Life	excellent	excellent	moderate
Safety Level	high	high	low
Self Discharge Rate	very low	very low	moderate
Operating Temp.	-55°C to 100°C	-55°C to 150°C	-55°C to 60°C

A comparison of performance characteristics among lithium batteries.

Plus™ bobbin cells, measuring 33 mm (diameter) x 61 mm (height), plus four Hybrid Layer Capacitors, measuring 15 mm (diameter) x 50 mm (height).

Conversion from Jelly Roll to Pulses Plus batteries resulted in a 25 percent size and weight reduction, as well as a 50 percent cost savings. The Pulses Plus™ solution is also safer for the drivers and the cargo.

Initial Promise

Of the various types of lithium batteries currently on the market, bobbin-type Li/SOCl2 cells combined with a Hybrid Layer Capacitor have shown initial promise for long-term, high-energy density/high-current pulse applications. Benefits include powerful performance, lower self-discharge and improved safety.

In specifying these batteries, design engineers need to consider the application requirements, as virtually all solutions are custom designed. Standard batteries range from 1.2 Ah to 19 Ah. Battery packs are also available including numerous configurations based upon voltage, capacity and size requirements.

As new applications arise, this and other lithium battery technologies will need to be continually refined to meet the demands of increasingly power-hungry devices. ■

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